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TEMPSHIP position errors, January - August 1993

by
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1 Introduction

Ingleby (1991, Appendix E) examined position errors for January to April 1991, and found an average of 4 errors per month (excluding one ship which gave 20 errors in one month). Unfortunately very little progress in detecting these errors has been made and the current study was intended to examine if the errors persist, and which methods might be most effective at detecting them.

Surface ships are also subject to position errors but this study concentrates on TEMPSHIPs because of their importance to the analysis and subsequent forecast.

2 Results

Table 1 lists the TEMPSHIPs considered to have wrong positions during the period. The positions are in degrees with North and East positive. The source of the correct position is given 'sf 12Z' means a surface report at 12Z, 'ua 11Z' is an upper-air report (another TEMPSHIP), 'est' implies an estimated position. The TEMPSHIP report is often one hour before the surface observation, so the positions will not agree exactly. Observations are used within a six hour window, so for example ZDLG at 23Z 31 January is used in the analysis for 00Z 1 February, and included in the February section. While an attempt has been made to be comprehensive this cannot be guaranteed (the FNOU error in January was almost overlooked), and which of the smaller deviations are errors requires subjective judgement.

The codes under the reported position are explained below. 8/14 1/15 in the quality control column implies that 8 of the 14 temperature levels and 1 of the 15 wind levels failed the automatic quality control. The original report is averaged over model levels and it is these averaged levels that are being considered. In two cases (V2LV 4 April and FNRS 1 May) some of the reported winds were omitted from the vertical averaging because of the quality control applied before that stage. Two reports were rejected by the Central Forecast Office (CFO). They are marked as CFOREJ and they are not buddy checked by the automatic quality control, but judging from the background flags they would have very largely passed the automatic quality control.

Some of the errors were detected by examining the tracks using an interactive graphical facility. Others were found by listing cases where upper-air and surface reports for the same ship and analysis time differed by more than 0.9° in either latitude or longitude. Both tracks were then examined to determine which, if either, was at fault. If observations are available both before and after the suspect report then even

small position errors show up as a kink in the track. Figure 1 shows the four position errors in January. A second kink in the track of FNPH suggests that there may be an extra rather small position error. Figure 2 shows the errors in August. There is a very obvious error in the track of V2LX, and a small kink which may be a minor error. The error in VRSI only shows up when the observation times are plotted (see insert) - comparison with the surface reports suggests that the 06Z position has been reported at 11Z.

Reference was also made to a list of TEMPSHIP and corresponding surface ship positions written-out by CFO support staff. This was instigated following the findings of Ingleby (1991) and maintained until late July 1993. Fewer than half the errors in Table 1 were noted in the CFO list.

Date time	call sign	reported position	correct position	source	quality control
	January 1993	717 observations			
7 11Z	ZDLG	(60.0, 40.9) Q, land	(-60.1, -41.1)	sf 12Z	8/14 1/15
22 11Z	FNOU	(34.3, -34.5) 4°	(38.3, -34.5)	est	0/16 0/15
23 10Z	DKIW	(23.6, -60.0) 10°	(23.6, -50.8)	sf 12Z	0/15 0/15
30 11Z	FNPH	(22.9, -51.9) 1°	(21.8, -51.2)	sf 12Z	0/16 0/16
	February 1993	594 observations			
31 23Z	ZDLG	(-48.0, -59.5) T	(-59.5, -48.0)	sf 00Z	CFOREJ
3 00Z	7JDU	(-0.6, 158.3) 2°	(-0.6, 156.2)	sf 00Z	0/15 0/15
8 11Z	DBBH	(-32.6, -10.5) Q	(32.6, 10.5)	est	0/15 1/15
9 11Z	DCMS	(47.1, -25.5) 10°	(47.2, -16.9)	sf 12Z	1/15 2/15
18 11Z	ZDLG	(-76.5, -26.4) 1°	(-75.4, -26.6)	sf 12Z	0/15 0/0
22 11Z	FNOR	(67.5, -48.8) 40°, land	(27.5, -48.8) (27.6, -48.7)	ua 11Z sf 12Z	0/0 7/10
	March 1993	857 observations			
1 23Z	V2LV	(28.0, -29.8) 2°	(29.7, -30.1)	sf 00Z	0/15 4/15
3 23Z	DESI	(68.5, 9.6) 2°	(68.6, 7.5)	sf 00Z	0/15 0/15
14 23Z	ZDLG	(-68.1, -66.4) T, land	(-66.2, -67.9)	sf 00Z	0/15 0/16

April 1993		743 observations			
4 11Z	V2LV	(51.9, -3.3)	(51.9, 3.3)	ua 11Z	2/16 1/10
		Q	(51.8, 4.1)	sf 12Z	
5 11Z	DBBH	(10.3, -18.5)	(8.8, -18.5)	est	0/15 0/15
		1.5°			
May 1993		700 observations			
1 11Z	FNRS	(-46.3, 17.3)	(46.3, -16.3)	ua 11Z	0/12 0/4
		Q			
12 23Z	V2LX	(43.4, -43.4)	(43.4, -13.4)	est	CFOREJ
		30°			
June 1993		654 observations			
25 00Z	LADB2	(52.4,-165.8)	(54.3,-166.3)	sf 00	0/16 0/16
		2°			
26 12Z	LADB2	(53.6,-179.8)	(53.6, 179.8)	ua 12	0/14 0/15
		Q (small)	(53.6, 179.3)	sf 12	
30 00Z	LADB2	(43.2, 152.1)	(46.2, 152.1)	est	2/13 0/5
		3°			
July 1993		689 observations			
29 23Z	SHIPS	(31.2, 13.4)	(41.2, 13.4)	est	1/15 11/15
		10°, land			
30 23Z	FNOR	(25.0, -52.2)	(22.0, -52.2)	est	1/16 0/16
		3°			
31 11Z	FNPH	(42.5, -23.5)	(43.5, -23.2)	sf 00	0/15 0/16
		1°			
August 1993		666 observations			
10 11Z	VRSI	(52.9, -49.7)	(53.0, -46.2)	sf 12	0/14 0/14
		3.5° (06Z position?)			
26 11Z	V2LX	(-27.7, -61.3)	(17.7, -61.3)	ua 11	0/15 9/15
		Q, 10°, land	(17.1, -61.1)	sf 12	

Table 1. TEMPSHIP position errors. See text for details.

2.1 Types of error

Of the 25 observations listed
6 had quadrant errors (denoted by Q)
2 had latitude and longitude transposed (denoted by T)
5 had errors in multiples of 10°
12 had other errors, mainly less than 3°. Of these some seem to have an error in the units digit and one or two (eg ZDLG 18 February) seem to have transposed the units and tenths digits.

Quadrant errors - The latitude and longitude are reported as unsigned integers in tenths of a degree and a quadrant. The

quadrant indicator takes values 1, 3, 5 or 7 depending whether the report is NE, SE, SW or NW of (0, 0). If the quadrant is reported wrongly then very large position errors can result.

2.2 Methods of detecting position errors

Land-sea check

For surface-ships and drifting buoys 'a check is applied to the reported latitude and longitude to discern whether any sea exists within the one-degree square occupied' by Synoptic Data-Bank routines (SDB, 1990). This is not currently applied to TEMPSHIPs.

Five of the erroneous TEMPSHIP reports in Table 1 were over land when compared to the coastline displayed. However two of these were quite close to the coast so they might or might not be flagged when compared to the SDB land-sea mask.

Comparison with surface position

Seventeen of the twenty-five TEMPSHIPs in Table 1 had surface reports at about the correct position, and comparing the two promises to detect more errors than any of the other individual checks. However this overestimates the proportion of errors that can be detected by comparison with surface observations since some of the small errors cannot be reliably detected in any other way. A rough division of the errors into 'large' and 'small' suggested that eight out of sixteen 'large' errors had corresponding surface reports.

Of course the surface positions can also be wrong. In the eight month period there were 82 distinct occasions where upper-air and surface positions disagreed by more than 0.9°, of these there were

17 TEMP SHIP errors
42 surface ship errors
9 unclear
14 cases with both TEMPSHIP and surface report correct (mainly at high latitudes)

Of the surface ship errors 24 came from V2LV and V2LX - see section 2.4.

Quality control

It is apparent that much of the information from the erroneous TEMPSHIPs passed the quality control and was used in the analysis. This is not surprising for the small errors of 1 or 2 degrees in position, but it is also true for many of the larger errors. The previous quality control system (used until June 1991) flagged the whole report for that variable if more than four levels had been rejected. On that basis only one of the temperature profiles and four of the wind profiles would have been rejected (another three wind profiles had large numbers of levels flagged before the vertical averaging). On its own comparison with the forecast background is not a reliable indicator of position errors.

Forecaster intervention

As noted in table 1 CFO rejected two of the erroneous TEMPSHIPs. However two other occasions were noted where CFO had incorrectly rejected a TEMPSHIP report: V2LV on 3 April 23Z (the surface report was at a wrong position) and DBBH on 2 April 11Z. The rather laborious manual writting out of positions seems to have been largely without effect.

2.3 Individual TEMPSHIP results

Table 2 shows the number of reports from each TEMPSHIP, the number of position errors and the months that the ship was reporting. The column labeled + gives the number that came in with corrupt callsigns, Ingleby (1991) found several position errors with incorrect callsigns but none were noted in the current study. Some ships are obviously more error-prone than others. Most of the errors are in the Atlantic sector, there are fewer TEMPSHIPs in the Pacific, but even fewer errors *pro rata*.

Ship	No	+	Err	Months
7JDU	31	0	1	F
DBBH	250	1	2	JFMAMJJA
DBLK	319	7		JFMAMJJA
DCMS	61	4	1	JF
DESI	137	2	1	JFM
DKIW	51	0	1	J
EREC	73	0		AMJ
FNOR	206	9	2	JFMAMJJA
FNOU	205	2	1	JFMAMJJA
FNPH	229	1	2	JFMAMJJA
FNRS	205	6	1	JFMAMJJA
GACA	845	2		JFMAMJJA
JBOA	73	0		JF AMJJA
JCCX	55	0		J A JJ
JDWX	67	0		JF AMJJA
JIVB	68	0		FM M JA
LADB2	207	0	3	JFMAMJJA
LDWR	940	2		JFMAMJJA
OVYA	131	1		FMAMJJA
OZJP	112	1		JFMAMJJA
P3OO4	147	4		MJJA
PNMAN	82			AMJJ
SHIP	52	0		AMJJA
SHIPS	30	0	1	JA
UJFO	35	1		M
UQYC	143	1		JFMAM
V2LV	269	6	2	FMAMJJA
V2LX	222	2	2	FMAMJJA
VPHA	23	0		JF
VRSI	140	4	1	AMJJA
ZDLG	153	0	4	JFMAM

Table 2. Ship callsign, number of reports, + number with incorrect callsign, number of position errors, months reporting.

This table was created using the SAS package.

Some wind profilers on Pacific Islands have been reporting both in TEMP MOBIL and TEMP SHIP code. Most of the callsigns start 'PS' and all TEMPSHIPs with these initial letters were omitted from this study. However PNMAN in table 2 is a wind profiler. If TEMPSHIPs were checked for ocean positions then it is possible that some of the profiler data would be flagged, however the islands are probably sufficiently small not to show up as land on the land-sea mask. It would be better if the profilers only reported in TEMP MOBIL code.

2.4 Surface reports

Stuck positions - In March and April ship V2LV frequently had positions that differed from the TEMPSHIP positions, on investigation it was found that the position was constant for two or more reporting times and then jumped a large distance. From 06Z 26 March to 06Z 28 March all the reports were at (22.8, -55.9) and from 12Z 30 March to 00Z 31 March the reports were at (39.1, -34.8). This behaviour carried on into April and also occured in August for both V2LV and V2LX, eg V2LX reported at (10.9, -68.1) from 06Z 24 to 00Z 25 August.

This will not be detected by the SDB ship movement check (SDB, 1990), which checks for ships moving too far, but not too little. In fact after a stationary period the next report (which is presumably correct) is in danger of being flagged. Because weather ships, research vessels and possibly trawlers do stay stationary or criss-cross in a limited area a blanket rejection of almost stationary ships would do more harm than good.

Quadrant errors - on occasion a series of surface reports were in the wrong quadrant. For example round 25 May five reports from FNOU were East instead of West.

Land - it was noted that some ships reporting at land positions were not being flagged. Surface observations with SDB position and movement flags have their initial 'probability of gross error in location' set to 0.75. They can still pass the quality control if the observed values agree reasonably closely with the background. It seems better to set the probability to 1.0 for position flags (ships over land) and 0.75 for movement flags (not 1.0 because it may be the previous position rather than the current one which is incorrect). This change was tested on five cases chosen at random. Of the twelve extra observations flagged three were over land, one may be on the Rhine, the other eight were in the St Lawrence which is not represented in the land-sea mask. However that area should be well covered by land synoptic stations so it has been decided to implement the change on 5 October 1993.

3 Discussion

The easiest extra check to add is against a land-sea mask, and this has the significant advantage of being decisive - observations over land can be discarded without further checking. Based on the results here it may reject 20-25% of errors.

Comparison with surface ship positions may detect up to about 70% of errors, but it has a large false alarm rate with over twice as many differences due to surface position errors. (This may be reduced when used in conjunction with the movement check on surface reports). This test cannot be used on its own therefore but must be used with either the background check or subjective inspection. It is important that flags from this test should be distinct from the land-sea test flags (at present there is just one position flag for any SDB test that considers the position suspect).

The background check on its own is rather poor at detecting position errors, additional information is needed to make it more effective.

Current CFO checking for position errors is hit-and-miss and even when the list of positions was being compiled by hand very ineffective. If it is decided that this is within the scope of CFO activities then adequate facilities should be provided, i.e. interactive plotting facilities to show TEMPSHIP and ship movements over the last week plus a list of TEMPSHIP/surface ship position disagreements.

It is clear that many of the errors are potentially correctable, however several days history of TEMPSHIP and ship movements would be needed to improve the identification of errors and to make corrections with any confidence. It would be possible but difficult to code such tests.

It is highly desirable that the data producers should reduce the error rate by increased automation and checks (against a NAVAID position, against the previous report etc). However this report has concentrated on actions that data users can take.

4. Summary

During the eight months January to August 1993 there was an average of three position errors a month from TEMPSHIPs, an error rate of about 0.5%. Some of the position errors are rather small but one or two a month are large enough to cause serious damage to the forecast if they escape quality control. Most of the erroneous information passes the quality control, but the largest differences from background are flagged. More winds than temperatures were flagged.

The detection of such errors should be improved by adding a land-sea check for TEMPSHIPs, plus a check against surface and/or previous TEMPSHIP positions.

5. References

Ingleby,N.B. 1991: Tuning and performance of the atmospheric quality control. Forecasting Research Technical Report No. 6.

SDB 1990: The quality control applied to surface land and ship reports. Met O (CC)3 Technical Note No. 3.

Figure 1. TEMPSHIP position errors : January 1993

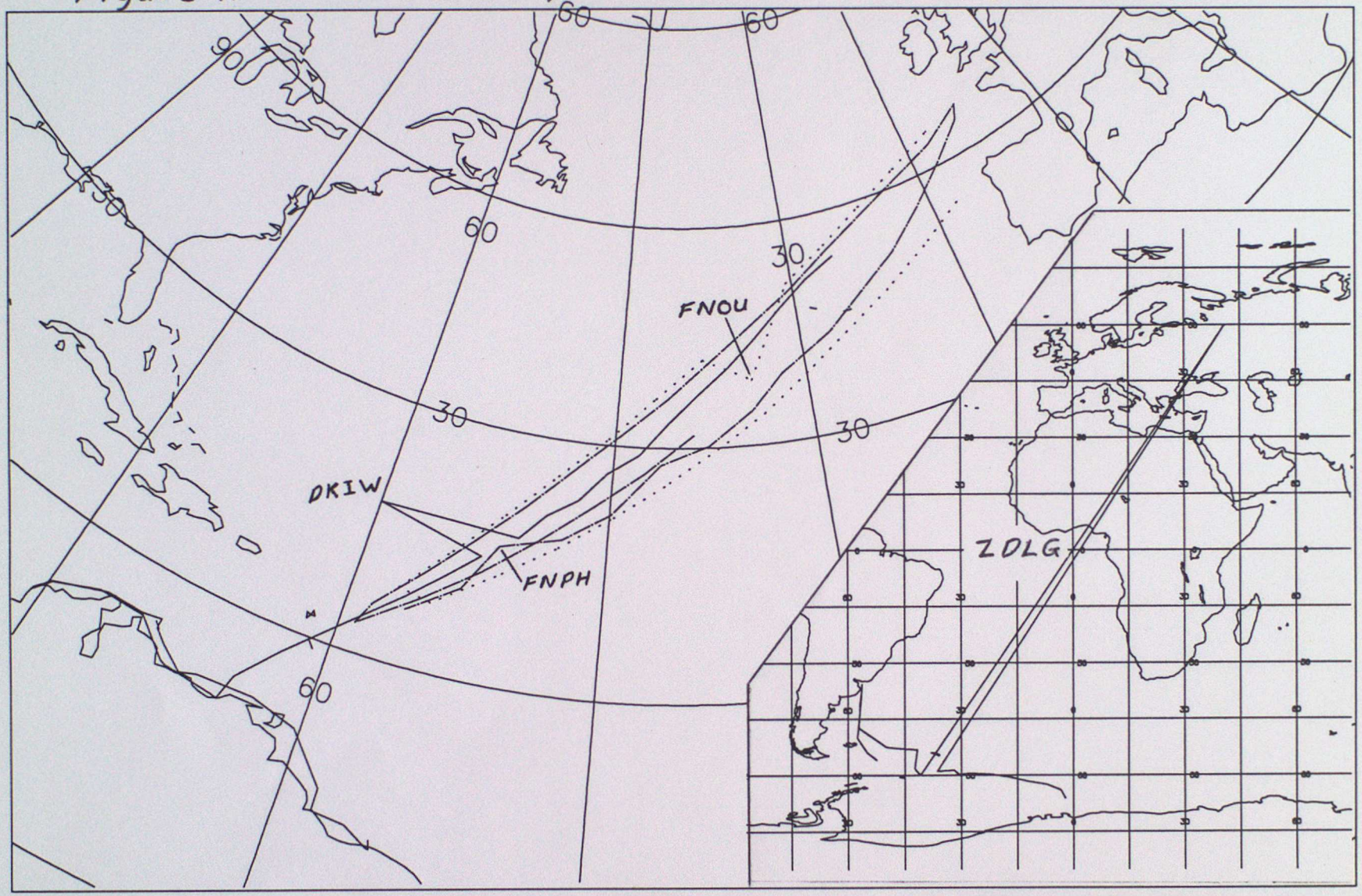
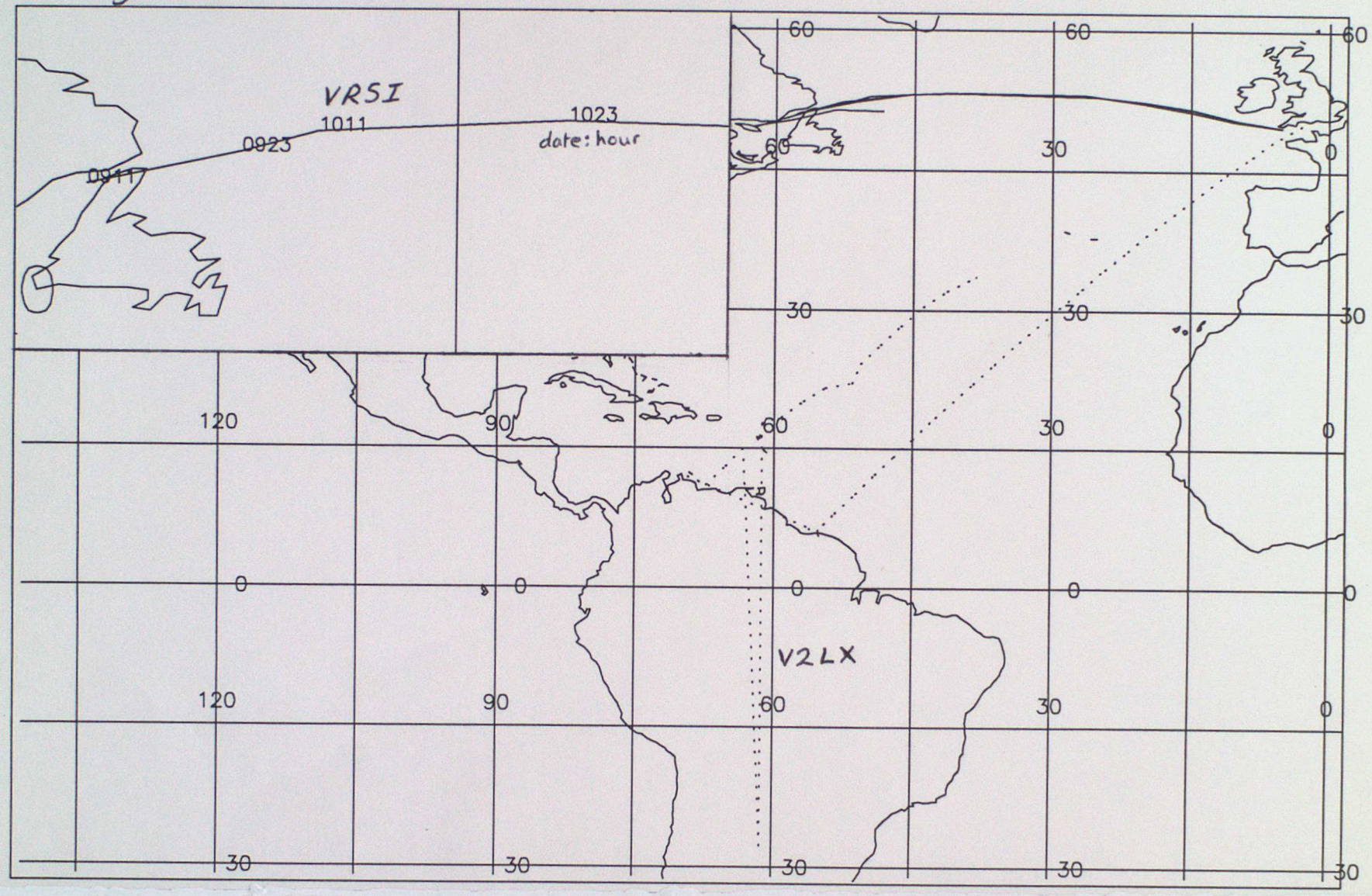
Figure 2. TEMPSHIP position errors : August 1993